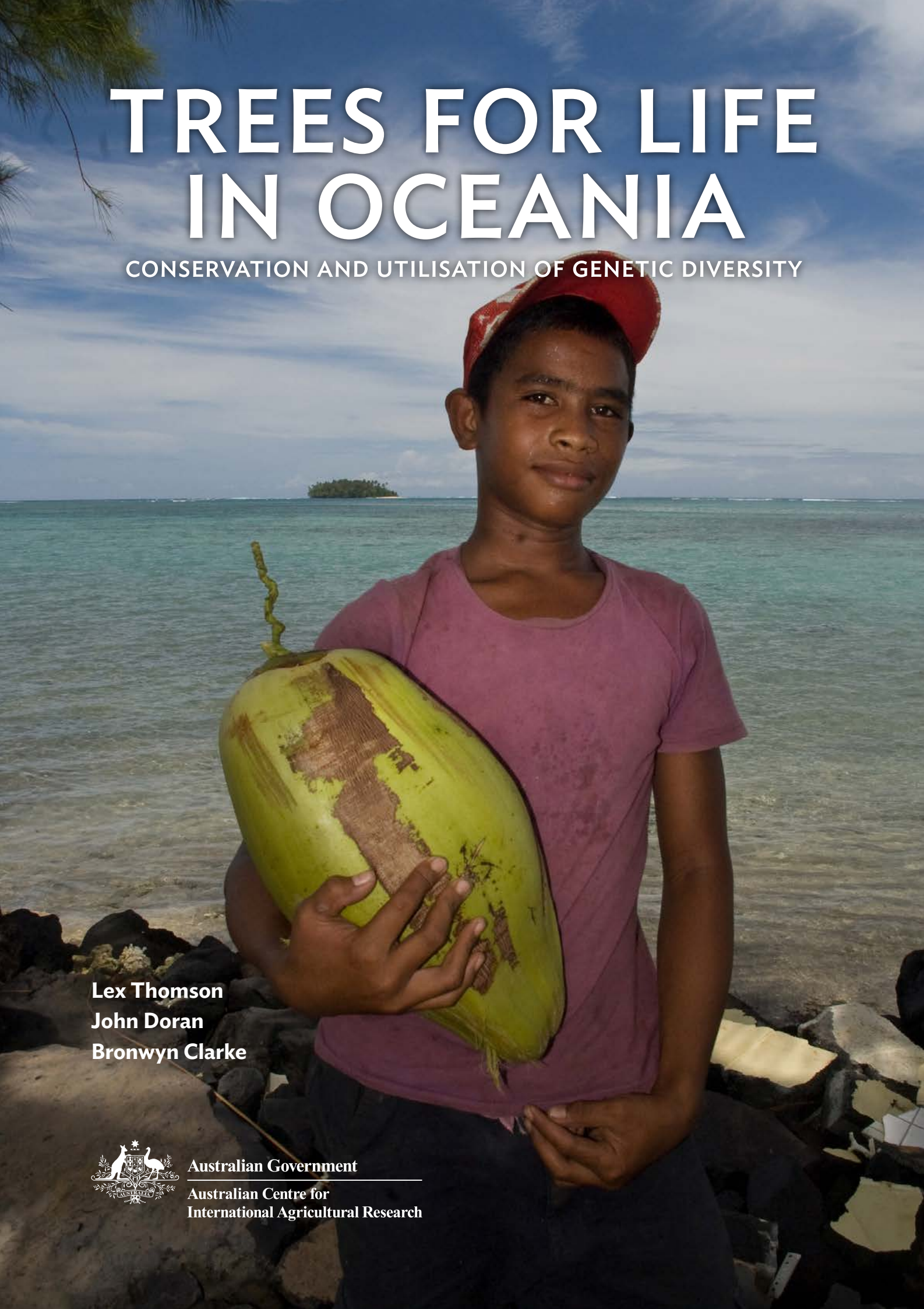


TREES FOR LIFE IN OCEANIA

CONSERVATION AND UTILISATION OF GENETIC DIVERSITY

Lex Thomson
John Doran
Bronwyn Clarke

Australian Government
Australian Centre for International Agricultural Research

Cocos nucifera (with a focus on Oceania)

Family: Arecaceae
Botanical name: *Cocos nucifera* L. In *Species Plantarum* p. 1188 (1753).

The genus name is from the Portuguese word *macaco*, monkey, alluding to the three small holes on the coconut shell that 16th century Portuguese sailors thought resembled a monkey's face. The specific epithet is from the Latin *nux*/*nucis*, nut, and *fero*, I bare.

Cocos nucifera is diploid with 32 chromosomes ($2n = 32$) and is the sole species of the genus *Cocos*. Being monotypic, hybrid cultivars are generally a product of intraspecific crosses.

Common names: coconut, coconut palm (English); *cocotier* (French); *nu* (Cook Islands); *niu* (Fiji; PNG; Polynesia); *niyog* (Guam; Philippines); *nizok* (Mariana Islands); *ni* (Marshall Islands); *haʻari* (Society Islands, French Polynesia)

Summary of attributes and why diversity matters

Coconut palms play a crucial role in the culture, environment, agriculture and tourism of the tropical Pacific Islands. The critical commercial and subsistence importance of the coconut palm means there is a great need to replant coconuts and to rehabilitate existing plantations that have deteriorated due to the decline in the copra trade.

Coconut varieties that have been passed down from generation to generation of Pacific Islanders are under threat from the globalisation of trade, cultural levelling, diseases and climate change. Due to fragility of insular ecosystems, the Pacific region is likely to be the location where losses are the most substantial and of the most socioeconomic importance due to the use of various coconut varieties as sources of food, fuel and other materials for low-income families.

Description

Habit erect tree-like palm ranging from dwarf forms to tall forms ≤30 m tall (see descriptions of different main types below). ***Bark*** smooth with prominent rings, greyish. ***Leaves*** pinnate fronds, typically ≤4 m in length, 1.2–1.8 m wide, bright green, clustered at top of trunk. ***Inflorescences*** bracts 45–90 cm long. ***Flowers*** monoecious, subsessile, in large axillary clusters, cream coloured. ***Fruit*** green, yellow or bronzy red when immature, brown when mature, large (to 30 cm long), subglobose to ellipsoid, with a thick fibrous husk surrounding a hard nut (endocarp) filled with a hard, white oily edible 'meat' or copra and, when young, with sweet water. ***Seed*** coherent with the endocarp; the female flower takes 10–12 months after pollination to mature as a viable seednut.

Traditional coconut varieties are classified in four main types:

Tall types represent 90–95% of all existing coconut palms. They are often simply called 'Talls'. They generally

Coconut plantation for production of copra; Shark Bay, Santo, Vanuatu (Photo: L. Thomson)

Coconut grove; Hawai'i, USA (Photo: J.B. Friday)

Fiji Tall variety; Suva, Fiji (Photo: L. Thomson)

Above left: The 'seven in one' coconut palms in Rarotonga, Cook Islands. One the most famous coconut palms in the South Pacific, with all seven palms reputed to have come from the same seednut planted in 1898 (Photo: R. Bourdeix)

Top right: Coconut plantation ('Fiji Tall' variety); Coral Coast, Viti Levu, Fiji (Photo: L. Thomson)

Bottom right: Coconut plantation; Hawai'i, USA (Photo: F. & K. Starr)

form quite heterogeneous cross-pollinating populations. Talls can grow at a rate of >50 cm annually when young and flower at 6–10 years with an economic life span of 60–70 years.

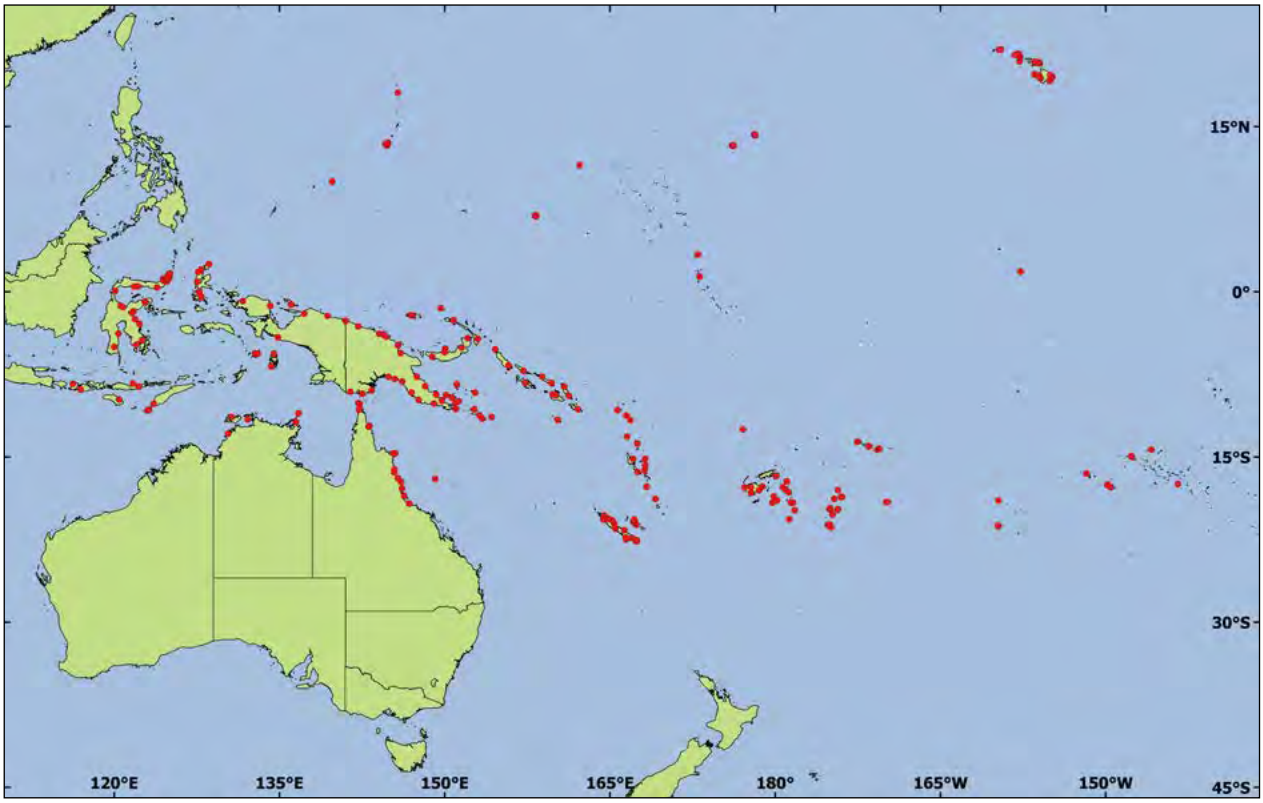
Preferentially Self-pollinating Dwarf types are often called 'Dwarfs', 'Fragile Dwarfs' or 'Malayan-type Dwarfs' (because the Malayan Red and Yellow Dwarfs are the most widely known cultivars of this type). They grow at a rate of 15–30 cm annually, have a productive life span of 30–40 years and usually start flowering 12–30 months after field planting. Apart from their usually short height, these varieties show a combination of common characteristics: autogamic preference, small size of organs, precocity and rapid emission of inflorescences. Because of the last two characteristics, they play an important role in genetic improvement programs.

Preferentially Cross-pollinating Compact Dwarf types are generally called simply 'Compact Dwarfs' or 'Niu Leka–type Dwarfs' (because the 'Niu Leka' Dwarf from Fiji is the most widely known cultivar of this type). This type of dwarf coconut is much rarer and mainly found in the Pacific region. Because of its very slow vertical growth and its thick stem being tolerant to cyclones, this form could play a crucial role in the future of coconut agriculture.

Semi-tall types include a few forms intermediate between Dwarfs and Talls, with variable reproduction modes. The most famous is the 'King Coconut' cultivar from Sri Lanka.

Distribution

The local names for coconut (*niu* in Polynesia and Melanesia, *niyog* in the Philippines and Guam) are derived from the Malay word *nyiur* or *nyior*. This is often cited as proof that the species originated in the Malay–Indonesian region. The coconut appears to have moved eastward towards the Pacific region and then further into the Americas. Towards the west, it moved to India and Madagascar. Evidence suggests that coconuts were spread by sea currents to many island groups. In addition, voyagers used to carry coconuts for food and drink; this enhanced the introduction of the crop to other destinations. By taking seednuts from one isolated island to another, early Pacific Islanders were able to reproduce and breed their own varieties in an empirical but stable manner.



Commercial production of coconuts occurs mainly on tropical coastal lowlands. However, the species can be cultivated up to an elevation of 1,200 m asl near the equator or ≤900 m at higher latitudes. Mean annual rainfall varies from (700–)1,200 to 2,300(–5,000) mm with a uniform or bimodal distribution and a dry season that can extend to 4 months. Growth and fruit production are reduced at the extremes. It prefers deep, fertile and well-drained soils of pH 5.5–6.5. It is self-pruning, highly resistant to wind damage and may tolerate some salinity but is intolerant of shade (as shade greatly diminishes or stops flowering/fruiting).

In the Pacific Islands, the coconut palm grows even in marginal coastal conditions, tolerating drought and poor soils. It is highly resilient, able to withstand severe tropical cyclones and flooding (of short duration). Small coral islets often continue to exist mainly because the palms' fibrous root systems prevent coastal erosion.

Uses

The coconut is popularly known as the 'Tree of Life' and all plant parts are useful. Coconut is an important livelihood and food security crop for >10 million farmers most of whom are smallholders, cultivating coconut palms worldwide on around 12 million ha. In 2014, FAO estimated the global production at 61.5 million tonnes, which equates to about 123 billion nuts/year, but this is thought to be a conservative figure.

Raising coconut seedlings in the nursery takes at least 6–12 months. The fruit has no dormancy, preventing storage of seednuts. The large size of the seednuts and the seedlings makes their transportation expensive, both for farmers (from seed gardens to their fields) and for genebanks (international movements of germplasm). Only about 65% of seednuts are generally selected as seedlings for field transfer. Planting densities generally

Roadside stall selling green coconuts for drinking; Tongatapu, Tonga (Photo: R.R. Thaman)

Above: Thatched coconut fronds being used for roofing insulation; Mangaia, Cook Islands (Photo: L. Thomson)

Right: Bottle of virgin coconut oil; Suva, Fiji (Photo: L. Thomson)

range between 80 and 300 trees/ha, depending on variety and cultural practices.

Wood—the trunk is used in house construction, fencing, animal pens, for other articles such as food containers, tools, walking sticks and, recently, for sawn timber cut in both portable and permanent timber mills.

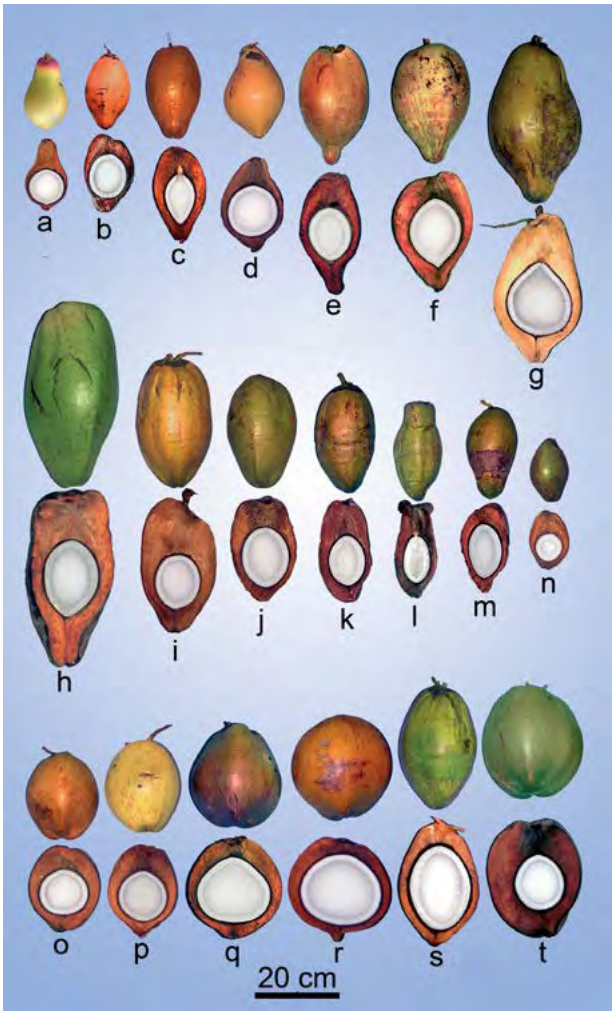
Non-wood—the leaves are used for thatched roofing and handicrafts; the sap from the spathe is processed into vinegar, wine and sugar; the husk is a source of fibre/coir for various uses; coconut shells can be burned into activated charcoal or carved as handicrafts and containers; the kernel is a source of oil, cream and desiccated coconut powder; and the water inside the nut used for beverage, wine and vinegar.

The market for coconut water is presently exploding. In 2016, coconut water had an annual turnover of about US$2 billion, but it is expected to reach US$4 billion within 5 years. In many countries, farmers are now cultivating dwarf-type coconut varieties for mass production of coconut water.

Diversity and its importance

Over millennia, humans have slowly selected and maintained numerous coconut varieties used for many purposes. It has resulted in an extraordinary morphological diversity which is expressed firstly by the range of colours, shapes and sizes of the fruit. Although the sequencing of coconut genome is now under investigation, the genetic structure of coconut germplasm is yet to be fully understood, which limits the exploitation of its diversity for genetic improvement.

In the Pacific region, coconut palms were first widely cultivated in the mid-1800s following an upsurge in European demand for oil and coir. From 1830 to 1930,



Variability in coconut fruit shape, colour and proportion of husk (Photo: R. Bourdeix)

Great phenotypic variation existing even in the very small atoll of Tetiaroa (only 12.8 km²) in French Polynesia: (1 to 6) long-shaped fruit of traditional varieties selected for the use of husk/coir (or a varietal mix including these varieties); (7, 8, 9 and 11) fruit with thin husk and a nipple at the distal end; (10) small wider fruit; (12) young fruit said to be of the 'Oviri' variety (medicinal coconut); (13, 14) big rounded fruit without nipple; (15) fruit with nipple and a very thin husk; (16) horned coconut from Onetahi Motu (Photo: R. Bourdeix)

following the development of the international market for copra (dried kernel), the number of palms planted in the Pacific region increased by 80–100%. The varieties that had been carefully selected over thousands of years by Pacific Islanders have been diluted by the mass of coconut palms that were planted solely for copra production.

Conservation of genetic resources (including threats and needs)

Coconut germplasm is conserved and used daily by millions of small farmers. Initiatives have been launched to recognise this prominent role, and to sustain it by promoting new multifunctional landscape management

'Nui Afa' traditional variety—a very large, long nut selected for production of fibre or coir; Samoa (Photo: R. Bourdeix)

approaches, such as the Polymotu concept.[1] For instance, in a project led by SPC and funded the Global Crop Diversity Trust, two small Samoan islands have been replanted for both conservation and ecotourism purposes with the famous traditional 'Niu Afa' variety, which produces the largest coconut fruit in the world. Factors impacting coconut in situ conservation include: constraints and advantages related to coconut biology; climate change; pests and diseases; links with ex situ conservation in institutional field genebanks; farmers' knowledge regarding the reproductive biology of their crop; socioeconomic dynamics; and legislative and policy measures. Despite the upturn in the global market, many coconut farmers remain insufficiently organised and poor and investments in coconut research remain scarce. Pests and diseases, such as the recent Guam biotype of the coconut rhinoceros beetle and lethal yellowing caused by phytoplasmas, are killing millions of coconut palms, ruining many farmers' livelihoods and eroding the precious genetic diversity of coconut varieties.

Authors: Roland Bourdeix and Pons Batugal

1 The Polymotu (many islands) concept uses the geographical isolation of special sites for conservation and reproduction of individual varieties of plants and animals, and dervives from previous initiatives in the conservation of coconut varieties by ancient Polynesians.